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Oguchi et al.

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(54) **POWER CONDITIONER SYSTEM AND POWER-STORAGE POWER CONDITIONER**

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PCT Pub. Date: **Apr. 4, 2013**

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(51) **Int. Cl.**
H02J 3/32 (2006.01)
H02J 3/38 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H02J 7/34*** (2013.01); ***H02J 3/32*** (2013.01); ***H02J 3/383*** (2013.01); ***H02J 7/35*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H02J 1/12; H02J 3/32; H02J 3/383; H02J 7/34; H02J 7/35; H02J 9/06;
(Continued)

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(57) **ABSTRACT**

A power conditioner system includes a power-generation power conditioner **30** for connecting a power generation equipment **11** to a grid **12** and a power-storage power conditioner **50** for connecting a power storage equipment **13** to the grid **12**, wherein the power conditioner **30** includes an independent-power-generation output unit **34** for outputting, separately from power supply to the grid **12**, power based on power of the power generation equipment **11**, and the power conditioner **50** includes an independent-power-storage output unit **54** for outputting, separately from power supply to the grid **12**, power based on power in the power storage equipment **13**. The power conditioner **50** supplies at least one of AC power based on the output of the independent-power-generation output unit **34**, AC power based on the
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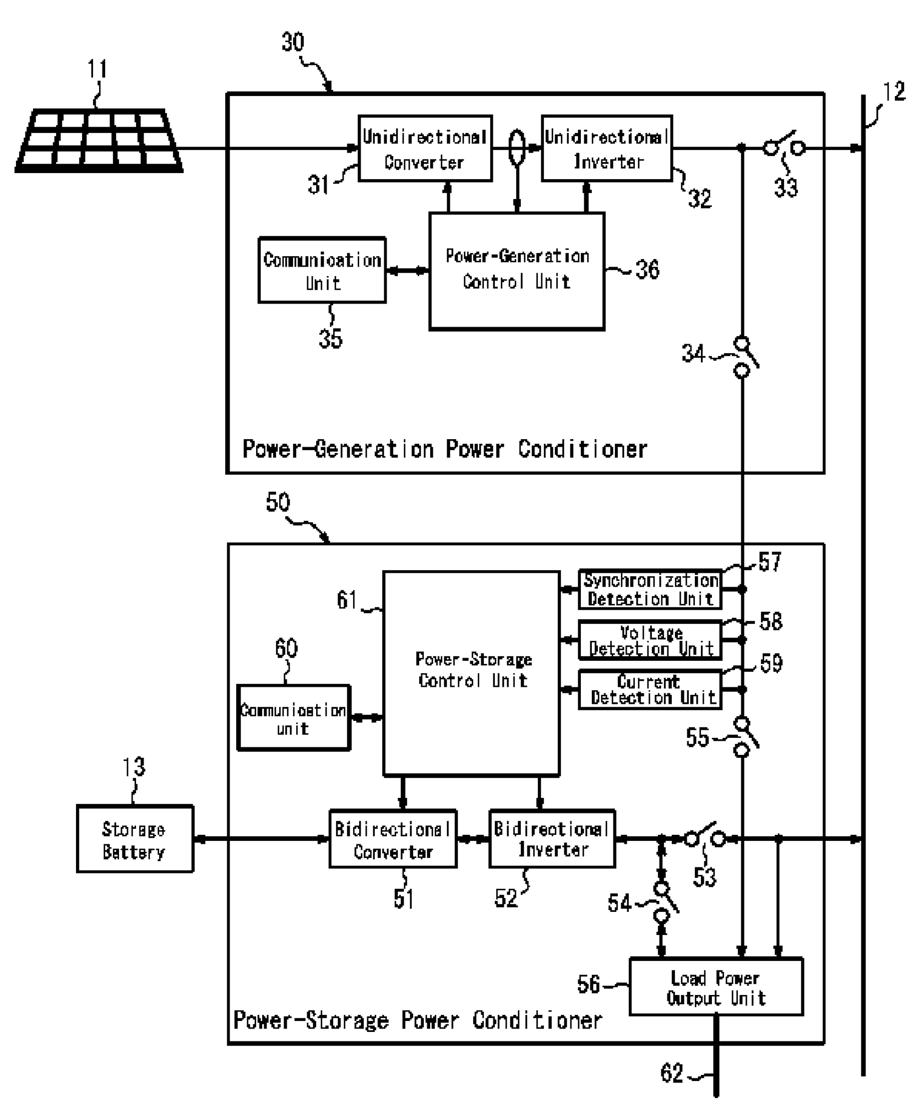

output of the independent-power-storage output unit **54**, and system power of the grid **12**, to an independent output system **62** having a predetermined load.

12 Claims, 11 Drawing Sheets

(51) **Int. Cl.**
H02J 7/35 (2006.01)
H02J 7/34 (2006.01)
H02J 3/00 (2006.01)

(52) **U.S. Cl.**
CPC *H02J 2003/007* (2013.01); *Y02E 10/563* (2013.01); *Y02E 10/566* (2013.01); *Y02E 60/76* (2013.01); *Y02E 70/30* (2013.01); *Y04S 40/22* (2013.01); *Y10T 307/328* (2015.04); *Y10T 307/344* (2015.04); *Y10T 307/359* (2015.04); *Y10T 307/516* (2015.04)

(58) **Field of Classification Search**
CPC Y02E 10/563; Y02E 10/566; Y02E 70/30; Y10T 307/328; Y10T 307/344; Y10T 307/359; Y10T 307/516
USPC 307/21, 23, 25, 46, 64, 80, 82, 126
See application file for complete search history.

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The extended European search report issued by the European Patent Office dated May 7, 2015, which corresponds to European Patent Application No. 12835434.7-1804 and is related to U.S. Appl. No. 14/348,549.
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FIG. 1

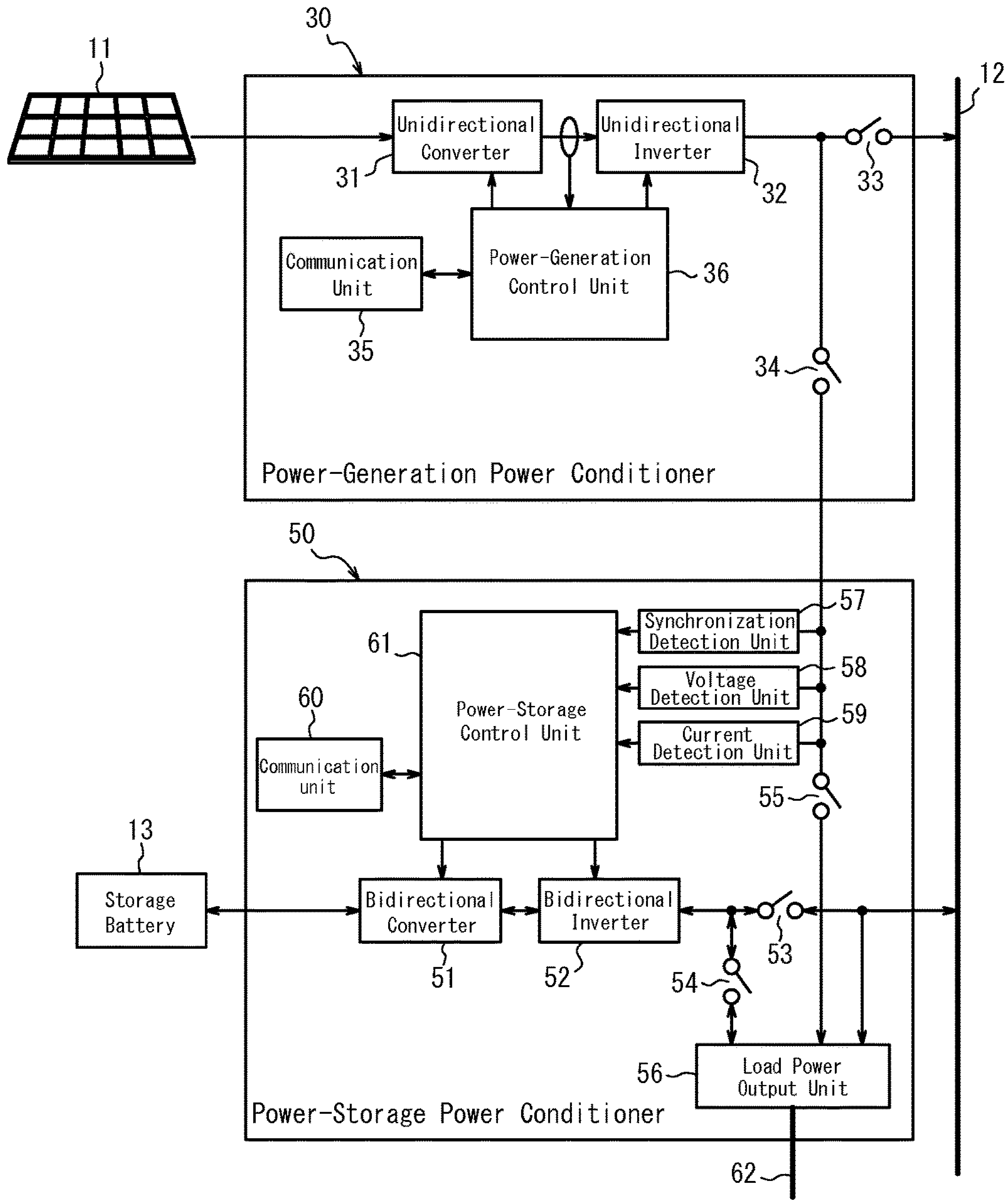
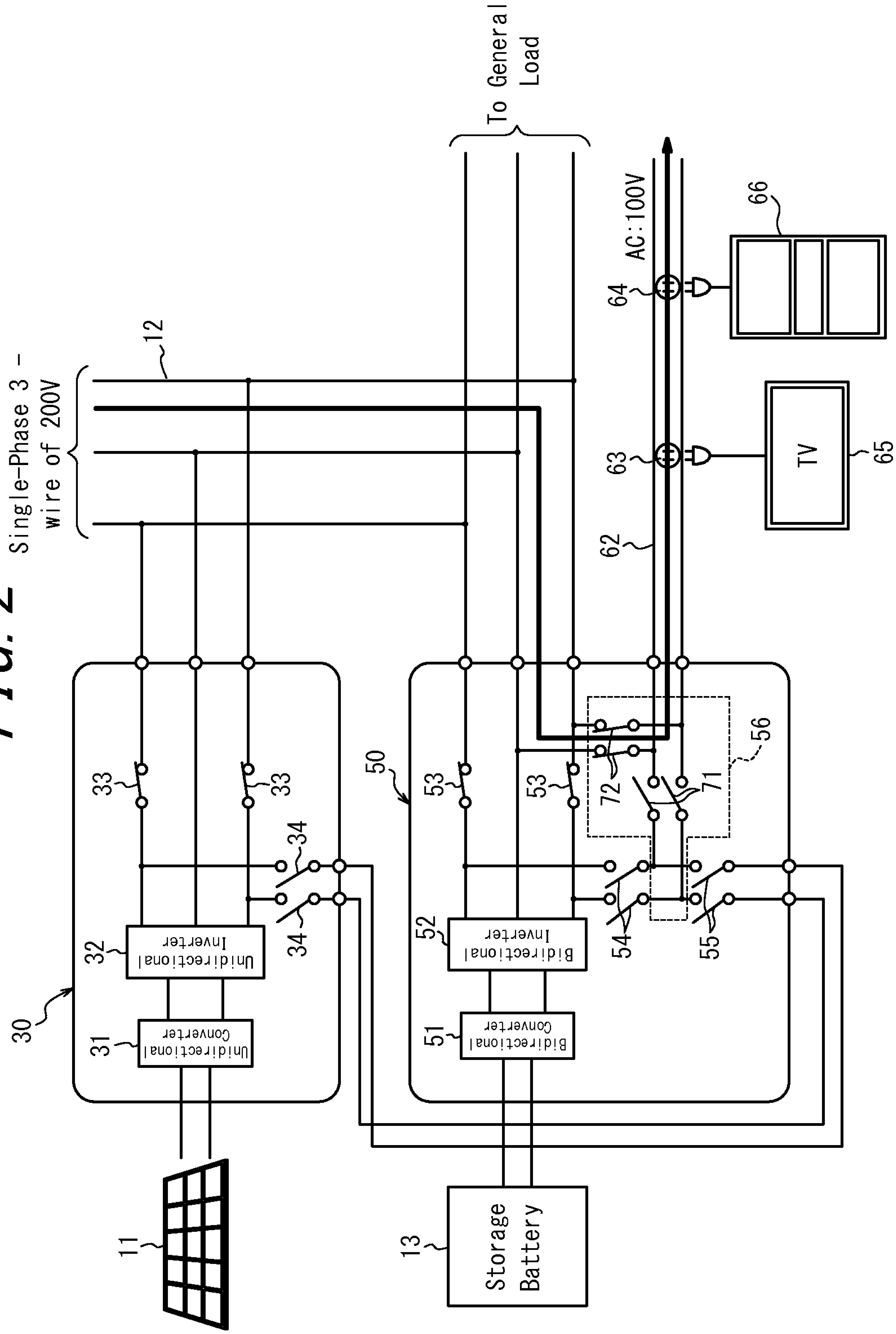

30
11
12
Unidirectional Converter
Unidirectional Inverter
31
32
33
Communication Unit
Power-Generation Control Unit
36
35
34
Power-Generation Power Conditioner
50
57
Synchronization Detection Unit
61
58
Voltage Detection Unit
Power-Storage Control Unit
60
59
Current Detection Unit
Communication unit
55
13
Storage Battery
Bidirectional Converter
Bidirectional Inverter
53
51
52
54
56
Load Power Output Unit
Power-Storage Power Conditioner
62

FIG. 2


Single-Phase 3-wire of 200V
To General Load
AC:100V
TV
Unidirectional Inverter
Unidirectional Converter
Bidirectional Inverter
Bidirectional Converter
Storage Battery
11
12
13
30
31
32
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71
72

FIG. 3

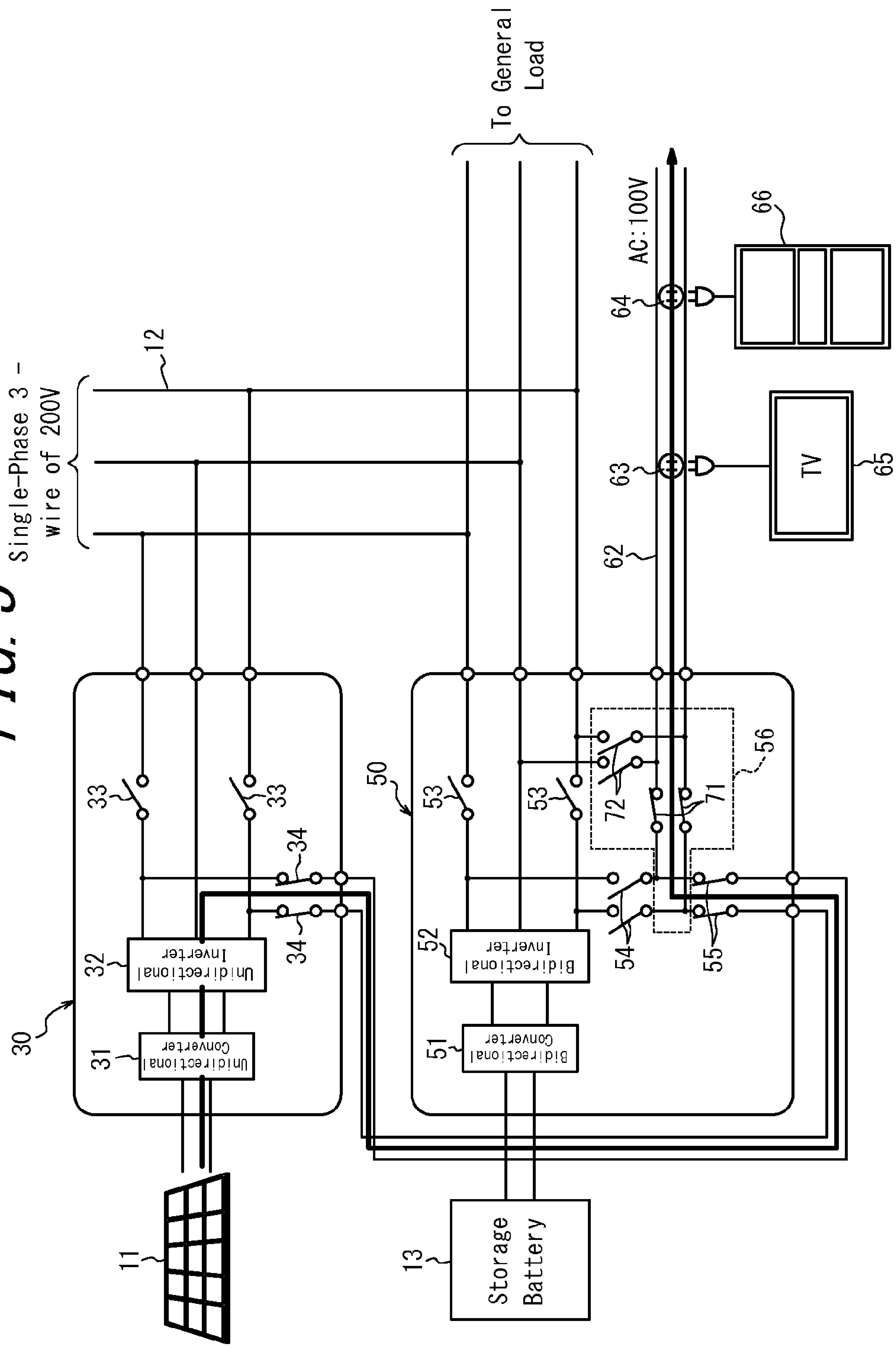
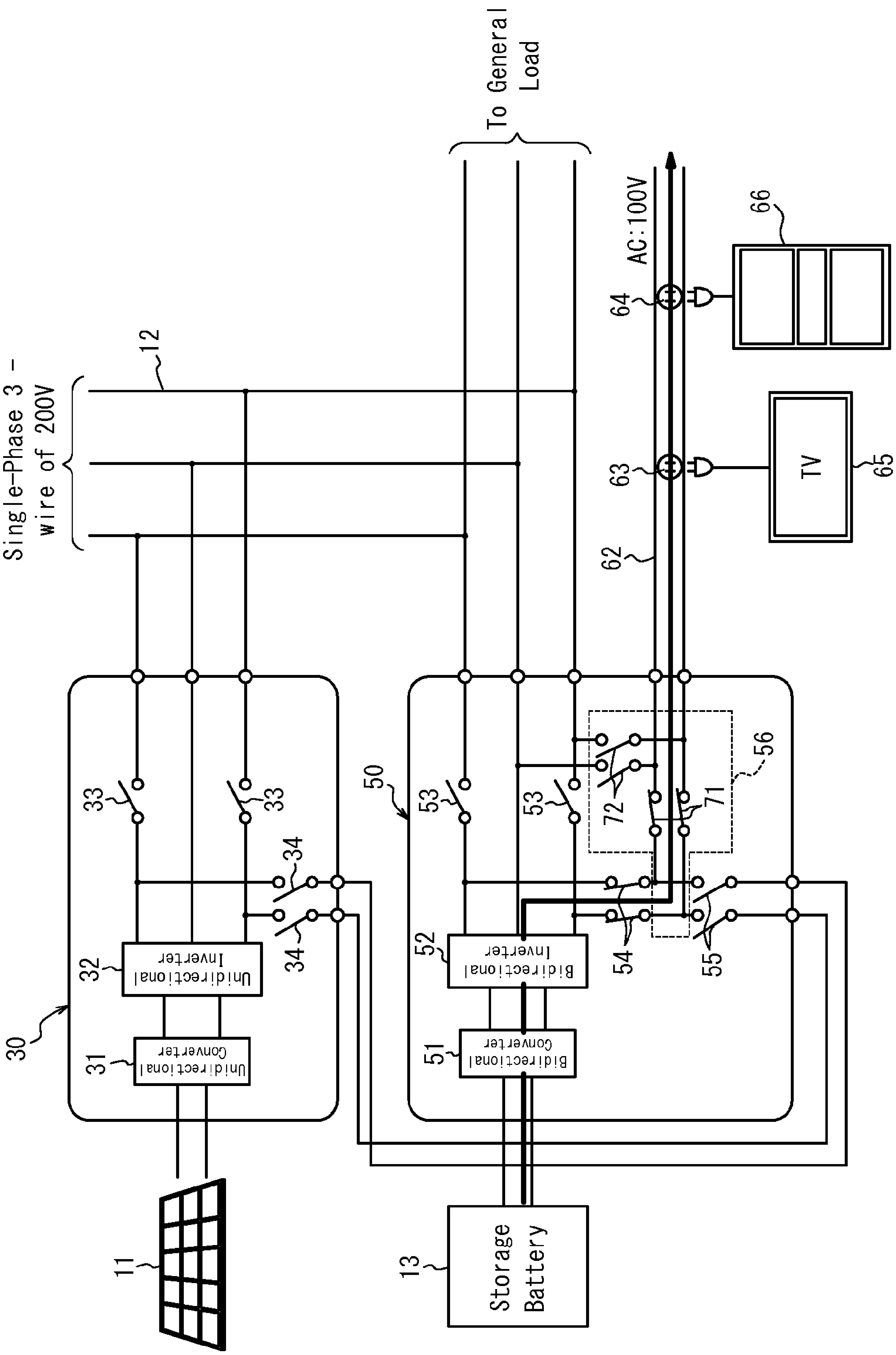

Single-Phase 3 - wire of 200V
12
To General Load
AC:100V
66
64
63
62
TV
65
30
33
33
34
34
32
Unidirectional Inverter
31
Unidirectional Converter
11
50
53
53
72
71
56
52
Bidirectional Inverter
54
55
51
Bidirectional Converter
13
Storage Battery

FIG. 4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To General Load
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62
65
TV
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31
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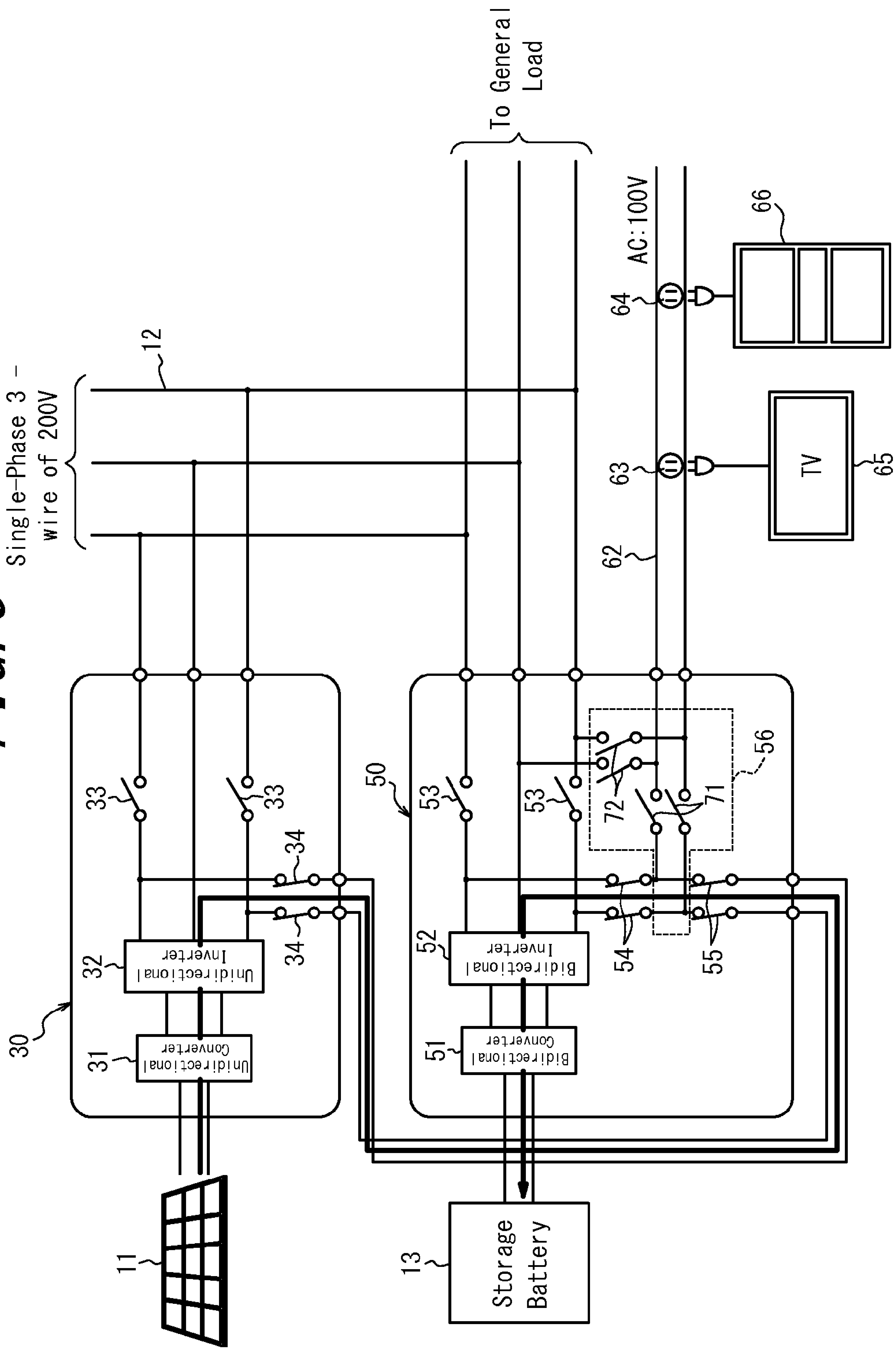
Unidirectional Inverter
33
33
34
34
50
51
Bidirectional Converter
52
Bidirectional Inverter
53
53
54
55
56
71
72
11
13
Storage Battery

FIG. 5


To General Load
Single-Phase 3 - wire of 200V
12
AC:100V
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64
63
62
65
TV
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Unidirectional Inverter
33
33
34
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50
51
52
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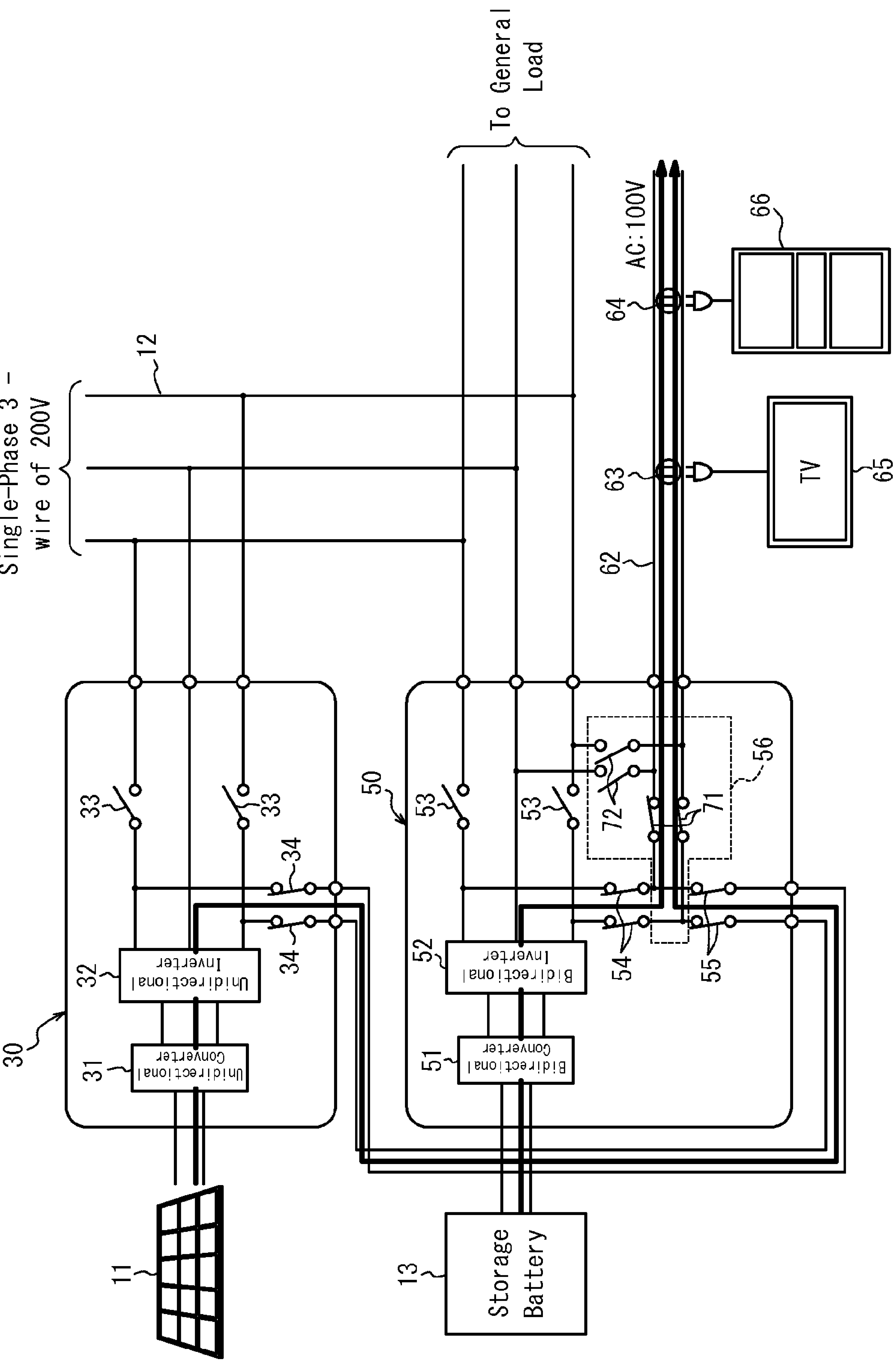
Bidirectional Inverter
53
53
54
55
56
71
72
11
13
Storage Battery



Single-Phase 3 - wire of 200V
12
To General Load
AC:100V
66
64
63
TV
65
62
30
33
33
34
34
32
Unidirectional Inverter
31
Unidirectional Converter
11
50
53
53
52
Bidirectional Inverter
51
Bidirectional Converter
54
55
56
71
72
13
Storage Battery

FIG. 6

FIG. 7

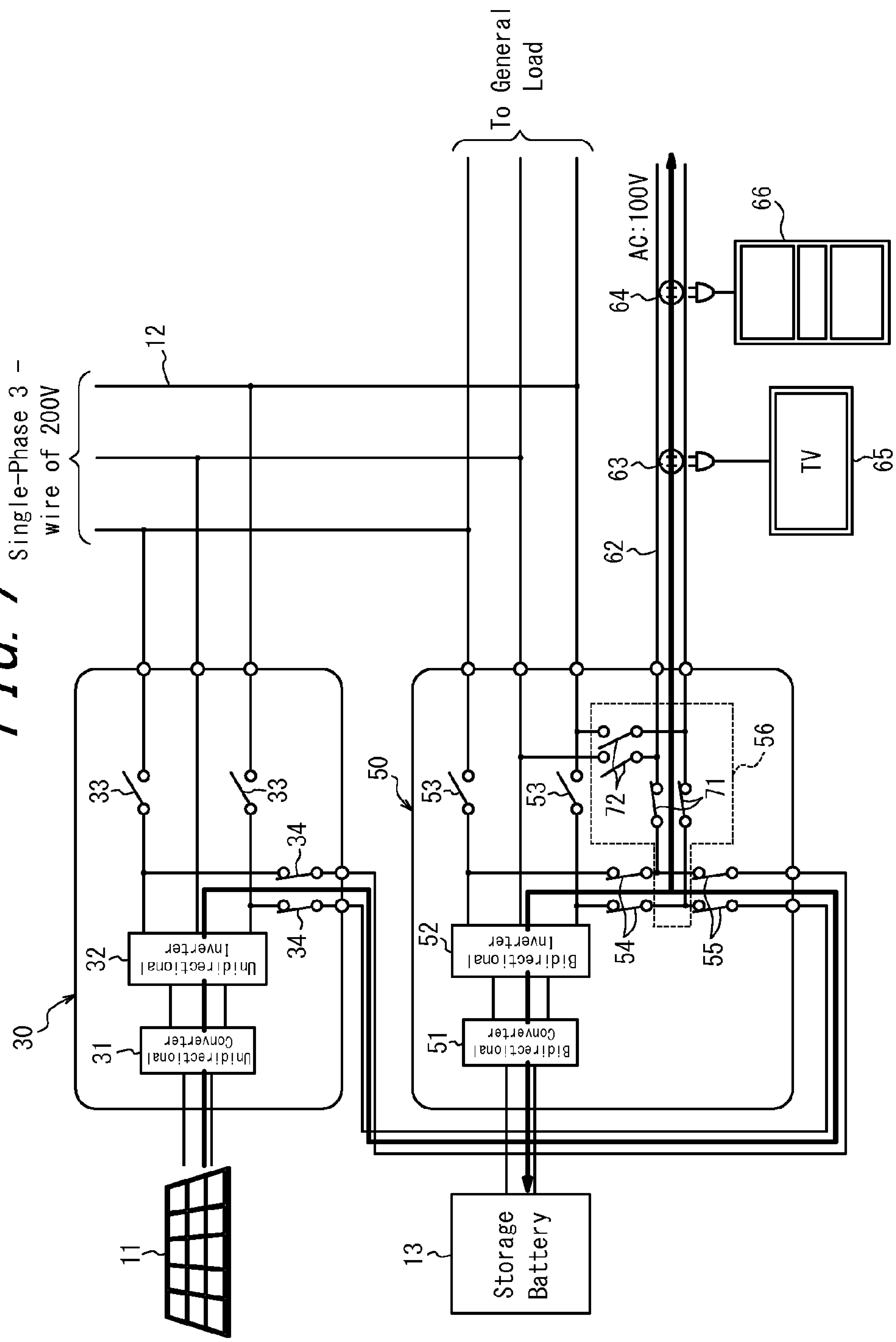
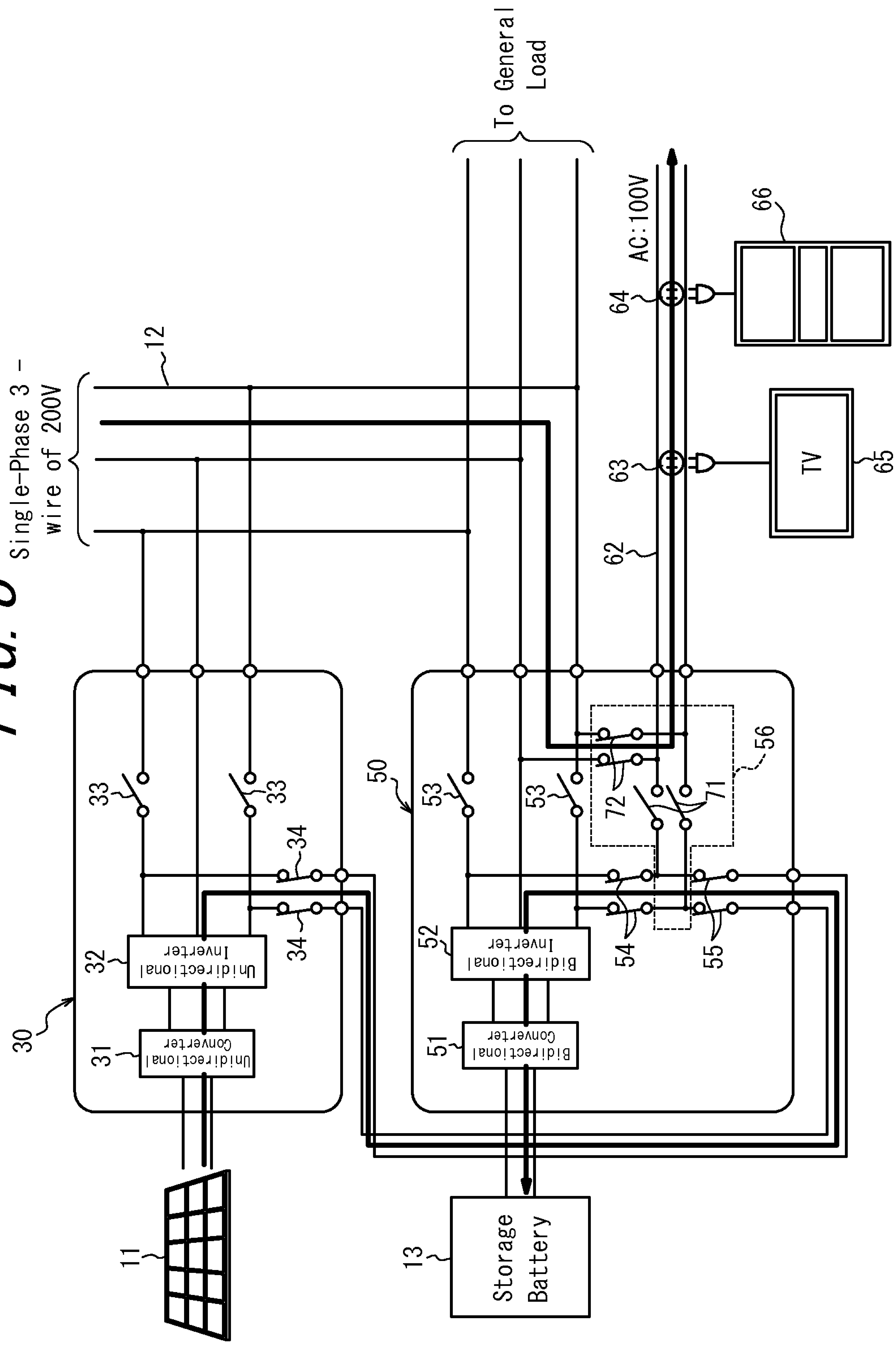

Single-Phase 3 - wire of 200V
12
To General Load
AC:100V
11
13
Storage Battery
30
31
Unidirectional Converter
32
Unidirectional Inverter
33
34
50
51
Bidirectional Converter
52
Bidirectional Inverter
53
54
55
56
62
63
64
65
TV
66
71
72

FIG. 8


Single-Phase 3-wire of 200V
12
To General Load
AC:100V
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TV
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31
Unidirectional Converter
32
Unidirectional Inverter
33
34
50
51
Bidirectional Converter
52
Bidirectional Inverter
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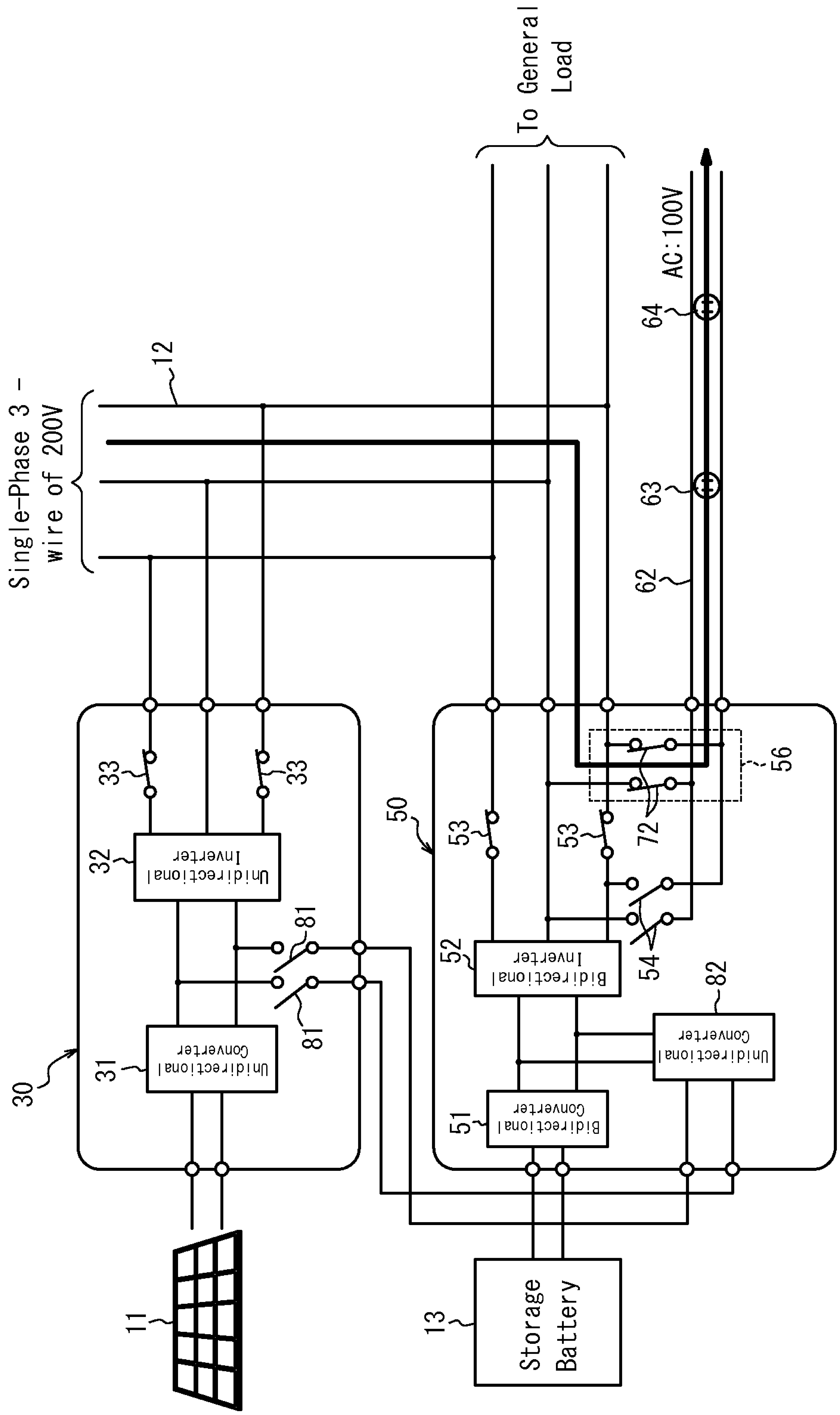
72
11
13
Storage Battery

FIG. 9


Single-Phase 3-wire of 200V
12
To General Load
AC:100V
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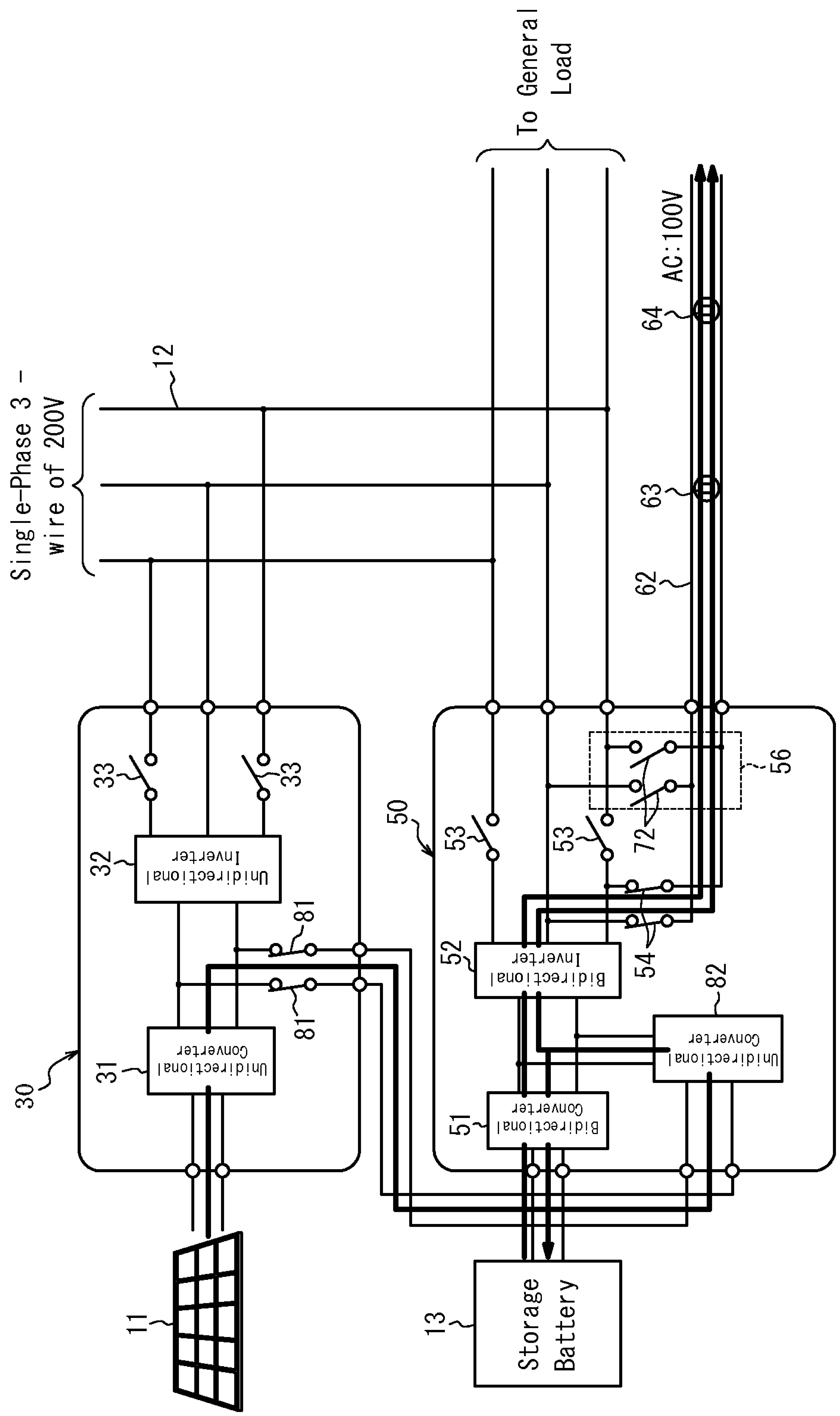
63
62
30
31
Unidirectional Converter
32
Unidirectional Inverter
33
33
81
81
50
51
Bidirectional Converter
52
Bidirectional Inverter
53
53
54
56
72
82
Unidirectional Converter
11
13
Storage Battery

FIG. 10


Single-Phase 3-wire of 200V
12
To General Load
AC:100V
64
63
62
30
31
Unidirectional Converter
32
Unidirectional Inverter
33
81
50
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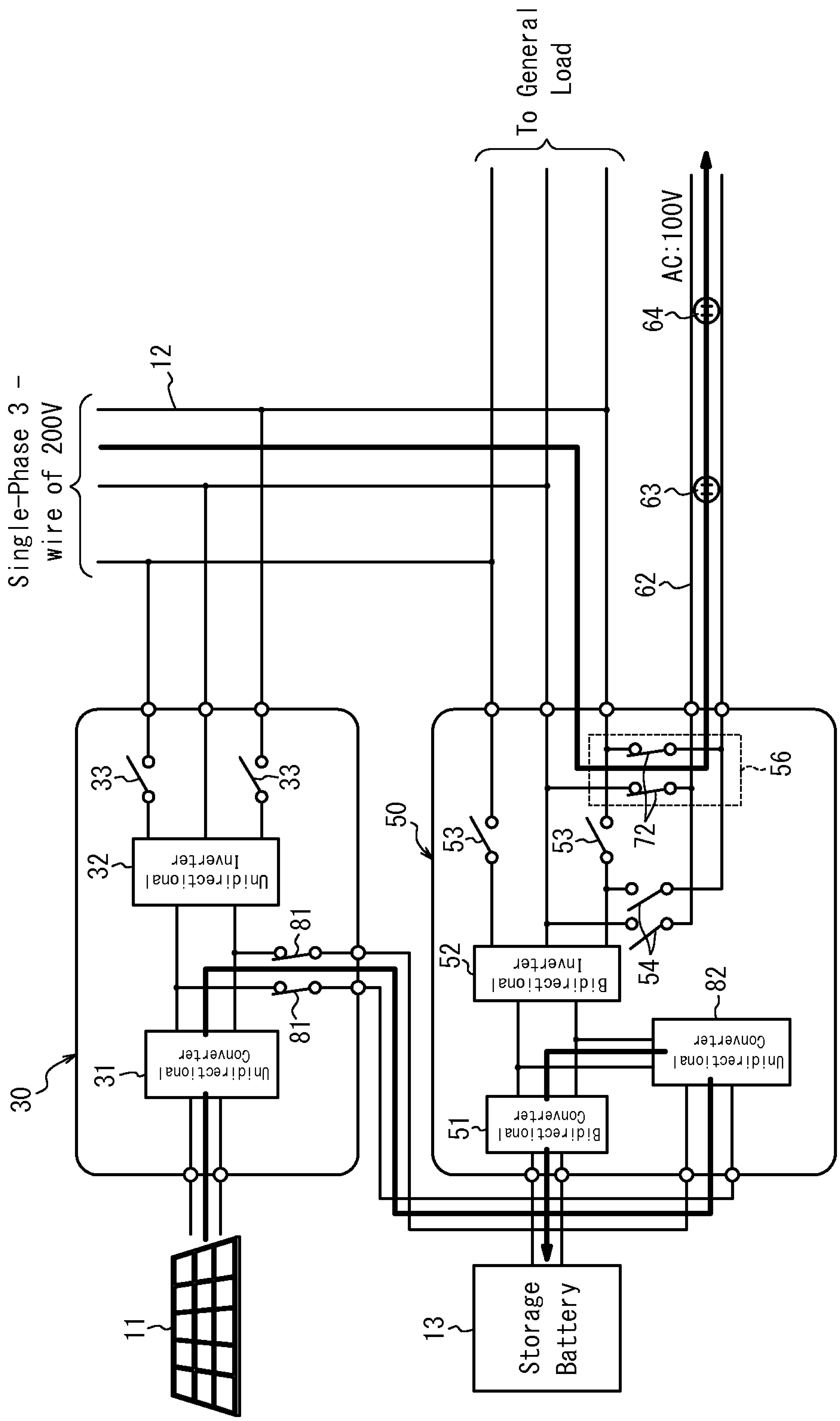
Bidirectional Converter
52
Bidirectional Inverter
53
54
56
72
82
Unidirectional Converter
11
13
Storage Battery

FIG. 11


Single-Phase 3 -
wire of 200V
12
To General
Load
AC:100V
64
63
62
30
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Unidirectional
Converter
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Unidirectional
Inverter
33
33
81
81
50
51
Bidirectional
Converter
52
Bidirectional
Inverter
53
53
54
56
72
82
Unidirectional
Converter
11
13
Storage
Battery

POWER CONDITIONER SYSTEM AND POWER-STORAGE POWER CONDITIONER

CROSS REFERENCE TO RELATED APPLICATION

This application claims priority to and the benefit of Japanese Patent Application No. 2011-213081 filed on Sep. 28, 2011, the entire contents of which are incorporated herein by reference.

FIELD

The present invention relates to a power conditioner system, and more specifically, to a novel power conditioner system that includes a combination of a power-generation power conditioner of a power generation system and a power-storage power conditioner of a power storage system, and also to the power-storage power conditioner.

BACKGROUND

As a power-generation power conditioner of a power generation system including a power generation equipment such as solar panels and the like, there has been known a power conditioner that allows a system interconnection operation for outputting AC power by interconnecting with a commercial power supply grid-system (hereinafter, appropriately abbreviated as a grid) and an independent operation for outputting the AC power without involving the grid (for example, see Patent Document 1).

Also, there has been known a power-storage power conditioner of a power storage system having a storage facility such as a storage battery or the like which is charged by power from the grid that, in a manner similar to the power-generation power conditioner described above, allows the grid interconnection operation for outputting the AC power by interconnecting with the grid and the independent operation for outputting the AC power without involving the grid (for example, see Patent Document 2).

CITATION LIST

Patent Document 1: Japanese Unexamined Patent Application Publication No. 2007-049770

Patent Document 2: Japanese Unexamined Patent Application Publication No. 2008-253033

SUMMARY OF INVENTION

Incidentally, in order to deal securely with power failure or the like of the grid, it is desired to install both of the power generation system and the power-storage system described above. In this case, however, it is assumed that simple installment of the power-generation power conditioner and the power-storage power conditioner separately from each other may cause the following disadvantages.

For example, when the power-generation power conditioner is focused on, in case of the grid power failure, an major load needs to be made offline from a system outlet connected to the grid and connected to an independent outlet connected to an independent output terminal of the power-generation power conditioner, that is, the major load requires a connection change, which is troublesome. Moreover, when solar panels are in use as the power generation equipment, since an output thereof depends on an amount of solar radiation, the major load may not be stably powered regardless of change of its connection to the independent outlet. Especially, when the grid power failure occurs during nighttime, power generated during daytime is unavailable and thus the major load may not be powered. Also, even when the grid power failure is not occurred, at the time of output suppression due to an increase in a system voltage, date/time designated by a calendar function, or an offline instruction by a PCS (Power Conditioner Subsystem) communication, the generated power is bound to be discarded, wasting generated power energy.

Also, when the power-storage power conditioner is focused on, an output may be stably supplied from the power storage equipment to the independent outlet connected to the independent output terminal of the power-storage power conditioner. However, in case of the grid power failure, in the same manner as the power-generation power conditioner, the trouble of changing connection of the major load from the grid outlet to the independent outlet of the power-storage power conditioner is required. In case of the grid power failure, further, since the power generation equipment is made offline from the grid, the power generated by the power generation equipment may not be stored in the power storage equipment, wasting the generated power energy.

The present invention in view of the above problems is primarily to provide a power conditioner system and a power-storage power conditioner that allow power supply to the major load in case of the grid power failure without requiring the trouble of changing connection of the major load.

In order to achieve the above matter, a power conditioner system according to the present invention includes a power-generation power conditioner configured to connect a power generation equipment to a grid and a power-storage power conditioner configured to connect a power storage equipment to the grid, such that the power-generation power conditioner includes an independent-power-generation output unit configured to output, separately from power supply to the grid, power based on generated power of the power generation equipment,

the power-storage power conditioner includes an independent-power-storage output unit configured to output, separately from power supply to the grid, AC power based on stored power in the power storage equipment, and

the power-storage power conditioner supplies at least one of AC power based on the output power of the independent-power-generation output unit, AC power based on the output power of the independent-power-storage output unit, and system power of the grid, to an independent output system having a predetermined load connected thereto.

According to one embodiment of the present invention, the power-storage power conditioner further includes an independent-power-generation input unit configured to input the power supplied from the independent-power-generation output unit and utilizes the power supplied from the independent-power-generation input unit for power storage of the power-storage power conditioner or for power supply to the independent-power-storage output unit.

According to one embodiment of the present invention, the power-generation power conditioner and the power-storage power conditioner include respective communication units for transmitting and receiving information including an operation state.

According to one embodiment of the present invention, the power-storage power conditioner charges the power storage equipment based on the output power of the independent-power-generation output unit.

According to one embodiment of the present invention, the power-storage power conditioner, when supplying the AC power based on the output power of the independent-power-generation output unit to the independent output system and the AC power is smaller than power consumption of the independent output system, compensates such a shortage with the AC power based on the output power of the independent-power-storage output unit.

According to one embodiment of the present invention, the power-storage power conditioner, when supplying the AC power based on the output power of the independent-power-generation output unit to the independent output system and the AC power exceeds the power consumption of the independent output system, stores such an excess in the power storage equipment.

According to one embodiment of the present invention, the power-generation power conditioner, at the time of suppression of output to the grid, makes itself offline from the grid and outputs power based on generated power of the power generation equipment from the independent-power-generation output unit and transmits information pertinent to the output suppression from the communication unit of the power-generation power conditioner to the power-storage power conditioner.

According to one embodiment of the present invention, the power-storage power conditioner, when the communication unit thereof receives the information pertinent to the output suppression from the power-generation power conditioner, makes itself offline from the grid and stores the output power of the independent-power-generation output unit in the power storage equipment.

According to one embodiment of the present invention, the power-generation power conditioner is subjected to output suppression upon increase in a system voltage of the grid, upon entering date/time designated by a calendar function, or upon an offline instruction received by the communication unit of the power-generation power conditioner itself.

According to one embodiment of the present invention, the power-generation power conditioner, when making itself offline from the grid, transmits information including the operation state from the communication unit thereof to the power-storage power conditioner and outputs power based on generated power of the power generation equipment from the independent-power-generation output unit.

According to one embodiment of the present invention, the power-generation power conditioner transmits information about power based on the generated power of the power generation equipment from the communication unit thereof to the power-storage power conditioner, and

the power-storage power conditioner, when the communication unit thereof receives the information about the power based on the generated power of the power generation equipment from the power-generation power conditioner, controls a charging amount of the power storage equipment based on the received information.

According to one embodiment of the present invention, the power-storage power conditioner, when detecting connection of the independent-power-generation output unit to the power-storage power conditioner, supplies at least one of the AC power based on the output power of the independent-power-generation output unit, the AC power based on the output power of the independent-power-storage output unit, and the system power of the grid, to a predetermined independent output system.

Further, in order to achieve the above object, a power-storage power conditioner according to the present invention configured to connect a power storage equipment to a grid, includes:

an independent-power-storage output unit configured to output, separately from power supply to the grid, power based on stored power in the power storage equipment, wherein

the power-storage power conditioner supplies at least one of AC power of the power-generation power conditioner, AC power based on the output power of the independent-power-storage output unit, and system power of the grid, to an independent output system having a predetermined load connected thereto.

According to the present invention, a power conditioner system and a power-storage power conditioner that, in case of the grid power failure, may supply power to an major load without requiring the trouble of changing connection of the major load may be provided.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a block diagram illustrating a schematic configuration of a power conditioner system according to a first embodiment of the present invention;

FIG. **2** is a diagram illustrating exemplary control carried out in normal operation by the power conditioner system in FIG. **1**;

FIG. **3** is a diagram illustrating exemplary control carried out by the power conditioner system in FIG. **1** in case of the grid power failure in order to supply an AC link output of a power-generation power conditioner to an independent output system;

FIG. **4** is a diagram illustrating exemplary control carried out by the power conditioner system in FIG. **1** in case of the grid power failure in order to supply an independent output of a power-storage power conditioner to the independent output system;

FIG. **5** is a diagram illustrating exemplary control carried out by the power conditioner system in FIG. **1** in case of the grid power failure in order to charge a power storage equipment with the AC link output of the power-generation power conditioner;

FIG. **6** is a diagram illustrating exemplary control carried out by the power conditioner system in FIG. **1** in case of the grid power failure in order to supply power, by combining the AC link output of the power-generation power conditioner and the independent output of the power-storage power conditioner, to the independent output system;

FIG. **7** is a diagram illustrating exemplary control carried out by the power conditioner system in FIG. **1** in case of the grid power failure in order to supply the AC link output of the power-generation power conditioner to the independent output system and to charge the power storage equipment with excess power of the AC link output;

FIG. **8** is a diagram illustrating exemplary control carried out by the power conditioner system in FIG. **1** in order to suppress output from the power-generation power conditioner to the grid;

FIG. **9** is a diagram illustrating a section of a power conditioner system according to a second embodiment of the present invention;

FIG. **10** is a diagram illustrating exemplary control carried out by the power conditioner system in FIG. **9** in case of the grid power failure; and

FIG. **11** is a diagram illustrating exemplary control carried out by the power conditioner system in FIG. **9** in order to suppress output from the power-generation power conditioner to the commercial power supply system.

DESCRIPTION OF EMBODIMENTS

The following is a description of embodiments of the present invention with reference to the accompanying drawings.

(First Embodiment)

FIG. **1** is a block diagram illustrating a schematic configuration of a power conditioner system according to a first embodiment of the present invention. The power conditioner system according to the present embodiment includes a power-generation power conditioner **30** for connecting a power generation equipment **11** to a commercial power supply system (grid) **12** and a power-storage power conditioner **50** for connecting a power storage equipment **13** to the grid **12**. Note that, according to the present embodiment, the power generation equipment **11** is configured by using a solar panel, and the power-generation power conditioner **30** is configured by using a solar power conditioner. Also, the power storage equipment **13** is configured by using a storage battery such as a lithium-ion battery, nickel-metal hydride battery or the like.

The power-generation power conditioner **30** includes a unidirectional converter **31**, a unidirectional inverter **32**, a system interconnection switch **33**, an independent output switch **34**, a communication unit **35**, and a power generation control unit **36**. The unidirectional converter **31** boosts a DC output voltage generated from the power generation equipment **11** and supplies the boosted DC output voltage to the unidirectional inverter **32**. An output voltage of the unidirectional converter **31** is detected as information about power based on generated power of the power generation equipment **11** (intermediate link information) by the power generation control unit **36**.

The unidirectional inverter **32** converts the DC voltage boosted by the unidirectional converter **31** into an AC current and supplies the AC current to the grid interconnection switch **33** and the independent output switch **34**. The grid interconnection switch **33** selectively reverses flow of the AC power output from the unidirectional inverter **32** to the grid **12**. The independent output switch **34** serves as an independent-power-generation output unit and selectively outputs the AC power output from the unidirectional inverter **32** as an AC link output to the power-storage power conditioner **50**. Note that a central value of the output voltage of the sunlight-power-generation and the power-storage power conditioner interconnecting with single-phase three-wire 200 V (the grid interconnection switch **33** being closed, and the independent output switch **34** being open) is 202 V. Also, a central value of the output voltage at the time of output of independent power generation (the grid interconnection switch **33** being open, and the independent output switch **34** being closed) is 101 V.

The control unit **35** communicates with a communication unit **60** of the power-storage power conditioner **50**, which will be described below, by either wired or wireless, in a direct manner or via a network. The communication unit **35** transmits information about an operation state including a voltage state inside the power-generation power conditioner **30** and the like to the communication unit **60** and, also, receives information including an operation state of a voltage state inside the power-storage power conditioner **50** from the communication unit **60**. Note that the information received by the communication unit **35** includes an offline instruction by a PCS communication and the like.

The power generation control unit **36** is configured by using, for example, a microcomputer. The power generation control unit **36**, based on a state such as an increase in a system voltage or power failure of the grid **12**, as well as the information received by the communication unit **35** and the like, controls an operation of each of the unidirectional converter **31**, the unidirectional inverter **32**, the grid interconnection switch **33**, the independent output switch **34**, and the communication unit **35**. Note that the grid interconnection switch **33** and the independent output switch **34** are separately controlled to be turned on/off by respective relays.

The power-storage power conditioner **50** includes a bidirectional converter **51**, a bidirectional inverter **52**, a system interconnection switch **53**, an independent output switch **54**, an AC link switch **55**, a load power output unit **56**, a synchronization detection unit **57**, a voltage detection unit **58**, a current detection unit **59**, a communication unit **60**, and a power-storage control unit **61**. The bidirectional converter **51** boosts a DC output voltage from the power storage equipment and supplies the boosted DC output voltage to the bidirectional inverter **52**. Also, the bidirectional converter **51** steps down the DC voltage converted by the bidirectional inverter **52** and supplies the stepped-down DC voltage to the power storage equipment **13**. Thereby, the power storage equipment **13** is charged.

The bidirectional inverter **52** converts the DC voltage boosted by the bidirectional converter **51** into an AC voltage and supplies the AC voltage to the independent output switch **54**. The grid interconnection switch **53** selectively outputs the AC power output from the bidirectional inverter **52** to a general load. Also, the bidirectional inverter **52** converts the grid voltage from the grid **12** input via the grid interconnection switch **53** into a DC current and supplies the DC current to the bidirectional converter **51**.

The grid interconnection switch **53** connects/disconnects the grid **12** and the bidirectional inverter **52**. The independent output switch **54** serves as an independent-power-storage output unit and selectively supplies the AC power output from the bidirectional inverter **2** to the load power output unit **56**. Also, the independent output switch **54** selectively supplies the AC link output from the power-generation power conditioner **30** to the bidirectional inverter **52**.

The AC link switch **55** corresponds to an independent-power-generation input unit and selectively supplies the AC link output from the power-generation power conditioner **30** to the load power output unit **56**. To the load power output unit **56**, a system power of the grid **12**, the AC link output from the power-generation power conditioner **30** output via the AC link switch **55**, and the AC output power of the bidirectional inverter **52** output via the independent output switch **54** are input. Then, the load power output unit **56** selects at least one of the three types of the input power described above and supplies the selected AC power to an independent output system **62** having an independent outlet having an major load connected thereto.

The synchronization detection unit **57**, the voltage detection unit **58** and the current detection unit **59** detect synchronization, a voltage and a current, respectively, of the AC link output from the power-generation power conditioner **30**. Results of the detection are supplied to the power-storage control unit **61**. The communication unit **60**, by communicating with the communication unit **35** of the power-generation power conditioner **30** described above, transmits the operation state including the voltage state inside the power-storage power conditioner **50** and receives the information transmitted from the communication unit **35**.

The power-storage control unit **61** is configured by using, for example, a microcomputer. The power-storage control unit **61**, based on the state such as an increase in the grid voltage or power failure of the grid **12**, and the results of the detection of the AC link output detected by the synchronization detection unit **57**, the voltage detection unit **58** and the current detection unit **59**, as well as the information received by the communication unit **60** and the like, controls an operation of each of the bidirectional converter **51**, the bidirectional inverter **52**, the grid interconnection switch **53**, the independent output switch **54**, the AC link switch **55**, the load power output unit **56**, and the communication unit **60**. Note that the grid interconnection switch **53**, the independent output switch **54**, and the AC link switch **55** are controlled to be turned on/off by respective separate relays.

Next, specific examples of control of the power conditioner system according to the present embodiment will be described with reference to FIG. **2** to FIG. **8**. Note that the exemplary controls described below are executed by, for example, the power-storage control unit **61** in FIG. **1** upon detection of connection of the power-generation power conditioner **30**, that is, upon connection between the independent output switch **34** of the power-generation power conditioner **30** and the AC link switch **55** of the power-storage power conditioner **50**.

In FIG. **2** to FIG. **8**, the grid **12** is represented by single-phase three-wire 200 V. In this case, each of the grid interconnection switch **33** of the power-generation power conditioner **30** and the grid interconnection switch **53** of the power-storage power conditioner **50** is connected to voltage lines. To the grid **12** of the single-phase three-wires, a general household load is connected. Also, in the examples, the independent output system **62** outputs an AC at 100 V and, to the independent outlets **63** and **64** of the independent output system **62**, a TV (television receiver) **65** and a refrigerator **66** are connected as major loads.

In FIG. **2** to FIG. **8**, further, the communication unit **35** and the power generation control unit **36** of the power-generation power conditioner **30** illustrated in FIG. **1** are omitted, and the synchronization detection unit **57**, the voltage detection unit **58**, the current detection unit **59**, the communication unit **60** and the power-storage control unit **61** of the power-storage power conditioner **50** are also omitted. In FIG. **2** to FIG. **8**, also, the load power output unit **56** of the power-storage power conditioner **50** is configured such that the independent output switch **54** and the AC link switch **55** are connected in series, a switch **71** is connected between in-series connection lines of the independent output switch **54** and the AC link switch **55** and the independent output system **62**, and a switch **72** is connected between the grid **12** and the independent output system **62**. Note that the switches **71**, **72**, in a manner similar to other switches, are turned on/off by respective relays.

FIG. **2** is a diagram illustrating exemplary control carried out in normal operation. Here, the normal operation means an operation in a state where the grid **12** does not have power failure and there is no output suppression of the power-generation power conditioner **30**. In this case, in the power-generation power conditioner **30** a control is conducted such that the grid interconnection switch **33** is turned on and the independent output switch **34** is turned off. Also, in the power-storage power conditioner **50** a control is conducted such that the grid interconnection switch **53** is turned on and the independent output switch **54** and the AC link switch **55** are turned off, and also such that the switch **71** of the load power output unit **56** is turned off and the switch **72** is turned on.

Thereby, to the independent output system **62**, as indicated by a bold arrow, the AC at 100 V is supplied via the grid **12** and the switch **72** of the load power output unit **56** to the major loads, the TV **65** and the refrigerator **66**. In the power-generation power conditioner **30**, when a power generation amount of the power generation equipment **11** based on an intermediate link voltage detected by the power generation control unit **36** satisfies a predetermined power generation amount, the AC output from the unidirectional inverter **32** flows in reverse through the grid interconnection switch **33** to the grid **12**, and thus excessive power is sold. In the power-storage power conditioner **50**, also, when an amount of power stored in the power storage equipment **13** is under a predetermined power storage amount or when a predetermined time has come, the power storage equipment **13** is charged with the AC power of the grid **12** via the grid interconnection switch **53**, the bidirectional inverter **52** and the bidirectional converter **51**.

FIG. **3** is a diagram illustrating exemplary control carried out in case of the grid power failure in order to supply the AC link output of the power-generation power conditioner **30** to the independent output system **62**. This exemplary control is carried out in case of power failure of the grid **12** when, for example, the power generation amount of the power generation equipment **11** satisfies the predetermined power generation amount. In this case, in the power-generation power conditioner **30** a control is conducted such that the grid interconnection switch **33** is turned off and the independent output switch **34** is turned on. Also, in the power-storage power conditioner **50** a control is conducted such that the grid interconnection switch **53** and the independent output switch **54** are turned off and the AC link switch **55** is turned on, and also such that the switch of the load power output unit **56** is turned on and the switch **72** is turned off.

Thereby, to the independent output system **62**, as indicated by a bold arrow, the AC link output from the unidirectional inverter **32** of the power-generation power conditioner **30** via the independent output switch **34** is supplied through the AC link switch **55** and the load power output unit **56** of the power-storage power conditioner **50**.

FIG. **4** is a diagram illustrating exemplary control carried out in case of the grid power failure in order to supply an independent output of the power-storage power conditioner **50** to the independent output system **62**. This exemplary control is carried out in case of power failure of the grid **12** when, for example, the power generation amount of the power generation equipment **11** does not satisfy the predetermined power generation amount and the amount of power stored in the power storage equipment **13** satisfies the predetermined power storage amount. In this case, in the power-generation power conditioner **30** a control is conducted such that the grid interconnection switch **33** and the independent output switch **34** are turned off. Also, in the power-storage power conditioner **50** a control is conducted such that the grid interconnection switch **53** and the AC link switch **55** are turned off and the independent output switch **54** is turned on, and also such that the switch **71** of the load power output unit **56** is turned on and the switch **72** is turned off.

Thereby, to the independent output system **62**, as indicated by a bold arrow, an independent output from the bidirectional inverter **52** of the power-storage power conditioner **50** via the independent output switch **54** is supplied through the switch **71** of the load power output unit **56**.

FIG. **5** is a diagram illustrating exemplary control carried out in case of the grid power failure in order to charge the power storage equipment **13** with the AC link output of the power-generation power conditioner **30**. This exemplary control is carried out in case of power failure of the grid **12** when, for example, the power generation equipment **11** is in a power-generating state but the power generation amount thereof does not satisfy the predetermined power generation amount, and the amount of power stored in the power storage equipment **13** does not satisfy the predetermined power storage amount. In this case, in the power-generation power conditioner **30** a control is conducted such that the grid interconnection switch **33** is turned off and the independent output switch **34** is turned on. Also, in the power-storage power conditioner **50** a control is conducted such that the grid interconnection switch **53** is turned off and the independent output switch **54** and the AC link switch **55** are turned on, and also such that both of the switches **71**, **72** of the load power output unit **56** are turned off.

Thereby, to the power storage equipment **13**, as indicated by a bold arrow, the AC link output from the unidirectional inverter **32** of the power-generation power conditioner **30** via the independent output switch **34** is supplied through the AC link switch **55**, the independent output switch **54**, the bidirectional inverter **52**, and the bidirectional converter **51** of the power-storage power conditioner **50**. In this case, accordingly, the AC at 100 V is not supplied to the independent output system **62**. Note that in this case the bidirectional inverter **52** and the bidirectional converter **51** of the power-storage power conditioner **50** are controlled by the power-storage control unit **61** based on the results of the detection of the AC link output by the synchronization detection unit **57**, the voltage detection unit **58** and the current detection unit **59** illustrated in FIG. **1**. Thereby, a charging amount of the power storage equipment **13** is controlled.

FIG. **6** is a diagram illustrating exemplary control carried out in case of the grid power failure in order to supply power, by combining the AC link output of the power-generation power conditioner **30** and the independent output of the power-storage power conditioner **50**, to the independent output system **62**. This exemplary control is carried out in case of power failure of the grid **12** when, for example, the AC link output alone of the power-generation power conditioner **30** does not satisfy power consumption of an major load connected to the independent output system **62**, and the independent output of the power-storage power conditioner **50** may aid the shortage. In this case, in the power-generation power conditioner **30** a control is conducted such that the grid interconnection switch **33** is turned off and the independent output switch **34** is turned on. Also, in the power-storage power conditioner **50** a control is conducted such that the grid interconnection switch **53** is turned off and the independent output switch **54** and the AC link switch **55** are turned on, and also such that the switch **71** of the load power output unit **56** is turned on and the switch **72** is turned off.

Thereby, to the independent output system **62**, as indicated by a bold arrow, the AC link output from the unidirectional inverter **32** of the power-generation power conditioner **30** via the independent output switch **34** is supplied through the AC link switch **55** of the power-storage power conditioner **50** and the switch **71** of the load power output unit **56**. To the independent output system **62**, also, the independent output from the bidirectional inverter **52** of the power-storage power conditioner **50** via the independent output switch **54** is supplied through the switch **71**.

Note that in this case the bidirectional converter **51** and the bidirectional inverter **52** of the power-storage power conditioner **50** are controlled by the power-storage control unit **61** based on the results of the detection of the AC link output by the synchronization detection unit **57**, the voltage detection unit **58** and the current detection unit **59** illustrated in FIG. **1**. Thereby, the independent output of the power-storage power conditioner **50** is synchronized with the AC link output from the power-generation power conditioner **30**, and controlled to be the power that is compensating the shortage of the output power by the AC link.

FIG. **7** is a diagram illustrating exemplary control carried out in case of the grid power failure in order to supply the AC link output of the power-generation power conditioner **30** to the independent output system **62**, and with excess output thereof, to charge the power storage equipment **13**. This exemplary control is carried out in case of power failure of the grid **12** when, for example, the power generation amount of the power generation equipment **11** exceeds the power consumption of the major load connected to the independent output system **62**, and the power storage equipment **13** may be charged. In this case, in the power-generation power conditioner **30** a control is conducted such that the grid interconnection switch **33** is turned off and the independent output switch **34** is turned on. Also, in the power-storage power conditioner **50** a control is conducted such that the grid interconnection switch **53** is turned off and the independent output switch **54** and the AC link switch **55** are turned on, and also such that the switch **71** of the load power output unit **56** is turned on and the switch **72** is turned off.

Thereby, to the independent output system **62**, as indicated by a bold arrow, the AC link output from the unidirectional inverter **32** of the power-generation power conditioner **30** via the independent output switch **34** is supplied through the AC link switch **55** of the power-storage power conditioner **50** and the switch **71** of the load power output unit **56**. Then, the excess of the AC link output exceeding the power consumption of the independent output system **62** is supplied to the power storage equipment **13** via the independent output switch **54**, the bidirectional inverter **52** and the bidirectional converter **51**, and thus the power storage equipment **13** is charged. Note that, in this case in a manner similar to FIG. **5**, the bidirectional inverter **52** and the bidirectional converter **51** of the power-storage power conditioner **50** are controlled by the power-storage control unit **61** based on the results of the detection of the AC link output by the synchronization detection unit **57**, the voltage detection unit **58** an the current detection unit **59** illustrated in FIG. **1**. Thereby, charging of the power storage equipment **13** is controlled.

FIG. **8** is a diagram illustrating exemplary control carried out to suppress output of the power-generation power conditioner **30** to the grid **12**. Here, the output suppression is executed upon increase in the grid voltage, upon entering date/time specified by a calendar function, or upon an offline instruction from the PCS communication. In this case, in the power-generation power conditioner **30** a control is conducted such that the grid interconnection switch **33** is turned off and the independent output switch **34** is turned on. Also, information pertinent to the output suppression of the power-generation power conditioner **30** is transmitted from the communication unit **35** to the power-storage power conditioner **50**. When the communication unit **60** of the power-storage power conditioner **50** receives the information pertinent to the output suppression described above, in the power-storage power conditioner **50** a control is conducted such that the grid interconnection switch **53** is turned off and the independent output switch **54** and the AC link switch **55** are turned on, and also such that the switch **71** of the load power output unit **56** is turned off and the switch **72** is turned on.

Thereby, to the independent output system **62**, as indicated by a bold arrow, the grid power of AC 100 V is supplied through the grid **12** and the switch **72** of the load power output unit **56**. Also, when the power generation equipment **11** is in the power-generating state and the power storage equipment **13** may be charged, the AC link output from the power-generation power conditioner **30**, in a manner similar to FIG. **5**, is supplied to the power storage equipment **13** through the AC link switch **55**, the independent output switch **54**, the bidirectional inverter **52** and the bidirectional converter **51** of the power-storage power conditioner **50**, and thus the charging amount of the power storage equipment **13** is controlled.

According to the present embodiment, as described above, unless the grid **12** has power failure, the grid power is supplied from the grid **12** to the independent output system **62** and, in case of power failure of the grid **12**, the AC power is supplied from the power-generation power conditioner **30** and/or the power-storage power conditioner **50** to the independent output system **62**. Accordingly, by connecting the major load to the independent output system **62**, the major load may be supplied with power in case of the grid power failure, allowing elimination of the need for connection change of the major load. Further, since the power storage equipment **13** may be charged with the power generated by the power generation equipment **11** at the time of the output suppression of the power-generation power conditioner **30** to the grid **12**, or at the time of the power failure of the grid **12**, waste of power energy may be eliminated

(Second Embodiment)

FIG. **9** is a block diagram illustrating a schematic configuration of a section of a power conditioner system according to a second embodiment of the present invention. In the following description, components having the same effects as the components illustrated in FIG. **1** to FIG. **8** will be denoted with the same reference numerals. The power conditioner system according to the present embodiment has a configuration illustrated in FIG. **1**, in which the DC power supplied from the unidirectional converter **31** of the power-generation power conditioner **30** to the unidirectional inverter **32** is selectively output, as a DC link output, from an independent output switch **81** corresponding to the independent-power-generation output unit to the power-storage power conditioner **50**. Note that the independent output switch **81** serves also as a DC link switch. The independent output switch **81** may be replaced with a switch included in a section where the power is supplied to a unidirectional converter **82** described below.

The power-storage power conditioner **50** includes the unidirectional converter **82** for converting the DC link output from the power-generation power conditioner **30** into a DC current at a predetermined voltage and supplying the DC current to the bidirectional converter **51** and the bidirectional inverter **52**. Note that the unidirectional converter **82** may be disposed after the independent output switch **81** in the power-generation power conditioner **30**. Accordingly, the independent-power-generation input unit may be composed of an input unit or an output unit of the unidirectional converter **82**. Also, the independent-power-generation input unit connects the independent output switch **54** for turning on/off AC output power of the bidirectional inverter **52** and the switch **72** (constituting the load power output unit **56**) for turning on/off the grid power in parallel with the independent output system **62**. Although other configurations are similar to that in FIG. **1**, FIG. **9** omits the independent output switch **34**, the AC link switch **55**, the synchronization detection unit **57**, the voltage detection unit **58**, the current detection unit **59** and the like illustrated in FIG. **1**.

The following is a description of more concrete examples of control of the power conditioner system according to the present embodiment. The following exemplary control is executed by the power-storage control unit **61** in FIG. **1** upon detection of, for example, connection of the power-generation power conditioner **30**, that is, connection of the independent output switch **81** of the power-generation power conditioner **30** and the unidirectional converter **82** of the power-storage power conditioner **50**.

FIG. **9** is a diagram illustrating exemplary control in normal operation. In this case, in the power-generation power conditioner **30** a control is conducted such that the grid interconnection switch **33** is turned on and the independent output switch **81** is turned off. Also, in the power-storage power conditioner **50** a control is conducted such that the grid interconnection switch **53** is turned on and the independent output switch **54**, and also such that the switch **72** of the load power output unit **56** is turned on.

Thereby, in a manner similar to FIG. **2**, the AC voltage at 100 V is supplied to the independent output system **62** from the grid **12** via the switch **12**. In the power-generation power conditioner **30**, when the power generation amount of the power generation equipment **11** satisfies the predetermined power generation amount, the AC output from the unidirectional inverter **32** is flown in reverse to the grid **12** via the grid interconnection switch **33**, and thus becomes sellable power. In the power-storage power conditioner **50**, on the other hand, when the amount of power stored in the power storage equipment **13** does not satisfy the predetermined power storage amount, the power storage equipment **13** is charged with the AC power of the grid **12** via the grid interconnection switch **53**, the bidirectional inverter **52** and the bidirectional converter **51**.

FIG. **10** is a diagram illustrating exemplary control carried out in case of the grid power failure. In this case, in the power-generation power conditioner **30** a control is conducted such that the grid interconnection switch **33** is turned off and the independent output switch **81** is turned on. Also, in power-storage power conditioner **50** a control is conducted such that the grid interconnection switch **53** is turned off and the independent output switch **54** is turned on, and also such that the switch **72** of the load power output unit **56** is turned off.

Then, when there is sufficient power generation amount of the power generation equipment **11**, the DC link output from the power-generation power conditioner **30** is boosted by the unidirectional converter **82** and then supplied to the bidirectional inverter **52**. To the independent output system **12**, then, the AC voltage from the bidirectional inverter **52** is supplied via the independent output switch **54**. At this time, when the power storage equipment **13** may be charged, the excess of the DC power from the unidirectional converter **82** is supplied to the power storage equipment **13** via the bidirectional converter **51**, and thus the power storage equipment **13** is charged. At this time, preferably, the power-generation power conditioner **30** or the power-storage power conditioner **50** detects the DC link output and, based on results of the detection, controls a charging amount of the power storage equipment **13**.

On the other hand, when the power generation amount of the power generation equipment **11** does not satisfy the power consumption of the independent output system **62**, in order to compensate the shortage, a stored-power output from the power storage equipment **13** is supplied to the bidirectional inverter **52** via the bidirectional converter **51**. Thereby, the AC power satisfying the power consumption is supplied to the independent output system **62**. Also, when the power generation equipment **11** is not in the power-generating state, a DC independent output from the bidirectional inverter **52** output based on the stored-power output of the power storage equipment **13** is supplied to the independent output system **62** via the independent output switch **54**.

FIG. **11** is a diagram illustrating exemplary control carried out in order to suppress output of the power-generation power conditioner **30** to the grid **12**. In this case, in the power-generation power conditioner **30** a control is conducted such that the grid interconnection switch **33** is turned off and the independent output switch **81** is turned on. Also, in the power-storage power conditioner **50** a control is conducted such that the grid interconnection switch **53** and the independent output switch **54** are turned off, and also such that the switch **72** of the load power output unit **56** is turned on.

To the independent output system **62**, thereby, the grid power of AC 100 V is supplied from the grid **12** via the switch **72** of the load power output unit **56**. Also, when the power generation equipment **11** is in the power-generating state, and the power storage equipment **13** may be charged, the DC link output from the power-generation power conditioner **30** is supplied to the power storage equipment **13** through the independent output switch **81**, the unidirectional converter **82** and the bidirectional converter **51** of the power-storage power conditioner **50**, and thus the power storage equipment **13** is charged. In this case also, preferably, the power-generation power conditioner **30** or the power-storage power conditioner **50** detects the DC link output and, based on results of the detection, controls the charging amount of the power storage equipment **13**.

According to the present embodiment also, therefore, in a manner similar to the first embodiment, by connecting the major load to the independent output system **62**, the major load may be powered regardless of the grid power failure, which eliminates the necessity of the connection change of the major load. Also, when the output of the power-generation power conditioner **30** to the grid **12** is suppressed or when the grid **12** has the power failure, the power generated by the power generation equipment **11** may be stored in the power storage equipment **13**, thereby eliminating waste of the power energy.

Note that the present invention is not limited to the above embodiments but various modifications and changes may be made. For example, some functions of the communication units **35**, **60** illustrated in FIG. **1** may be omitted when, for example, an output suppression interconnection function is eliminated. In the first embodiment, also, the synchronization detection unit **57**, the voltage detection unit **58** and the current detection unit **59** of the power-storage power conditioner **50** for detecting the AC link output may be omitted when some control algorithm or system configurations are used. In the first embodiment, moreover, the independent output switch **34** of the power-generation power conditioner **30** may be omitted while an output terminal of the AC link output is used as the independent-power-generation output unit.

In the second embodiment, also, the independent output switch **81** of the power-generation power conditioner **30** may be disposed in the power-storage power conditioner **50** to be used as the DC link switch while the power-generation power conditioner **30** uses an output terminal of the DC link output as the independent-power-generation output unit. In the second embodiment, moreover, when the output voltage from the unidirectional converter **31** of the power-generation power conditioner **30** exceeds the output voltage from the bidirectional converter **51** of the power-storage power conditioner **50** to the bidirectional inverter **52**, the unidirectional converter **82** of the power-storage power conditioner **50** may be omitted. Further, the present invention is not limited to the solar panels but also applicable when the power generation equipment **11** is another power generation equipment such as a wind power generation equipment and the like. Similarly, the present invention is also applicable when the power storage equipment **13** is not the battery but another storage equipment such as an electric double layer capacitor or the like.

REFERENCE SIGNS LIST

11 power generation equipment
12 grid
13 power storage equipment
30 power-generation power conditioner
31 unidirectional converter
32 unidirectional inverter
33 system interconnection switch
34 independent output switch
35 communication unit
36 power-generation control unit
50 power-storage power conditioner
51 bidirectional converter
52 bidirectional inverter
53 system interconnection switch
54 independent output switch
55 AC link switch
56 load power output unit
57 synchronization detection unit
58 voltage detection unit
59 current detection unit
60 communication unit
61 power-storage control unit
62 independent output system
71, **72** switch
81 independent output switch
82 unidirectional converter

The invention claimed is:

1. A power conditioner system comprising:

a power-generation power conditioner configured to connect a power generation equipment to a grid; and

a power-storage power conditioner configured to connect a power storage equipment to the grid,

wherein

the power-generation power conditioner includes an independent power-generation output unit configured to output, separately from power supply to the grid, power based on generated power of the power generation equipment,

the power-storage power conditioner includes an independent-power-storage output unit configured to output, separately from power supply to the grid, power based on stored power in the power storage equipment, and

the power-storage power conditioner supplies at least one of AC power based on the output power of the independent-power-generation output unit, AC power based on the output power of the independent-power-storage output unit, and system power of the grid, to an independent output system having a predetermined load connected thereto.

2. The power conditioner system according to claim **1**, wherein the power-storage power conditioner further includes an independent-power-generation input unit configured to input power supplied from the independent-power-generation output unit, and the power-storage power conditioner utilizes the power supplied from the independent-power-generation input unit for power storage of the power-storage power conditioner or for power supply to the independent-power-storage output unit.

3. The power conditioner system according to claim **1**, wherein the power-generation power conditioner and the power-storage power conditioner include respective communication units for transmitting and receiving information including an operation state.

4. The power conditioner system according to claim **1**, wherein the power-storage power conditioner charges the power storage equipment based on the output power of the independent-power-generation output unit.

5. The power conditioner system according to claim **1**, wherein the power-storage power conditioner, when supplying AC power based on the output power of the independent-power-generation output unit to the independent output system and the AC power is smaller than power consumption of the independent output system, compensates such a shortage with the AC power based on the output power of the independent-power-storage output unit.

6. The power conditioner system according to claim **1**, wherein the power-storage power conditioner, when supplying the AC power based on the output power of the independent-power-generation output unit to the independent output system and the AC power exceeds the power consumption of the independent output system, stores such an excess in the power storage equipment.

7. The power conditioner system according to claim **3**, wherein the power-generation power conditioner, at the time of suppression of output to the grid, makes itself offline from the grid and outputs power based on generated power of the power generation equipment from the independent-power-generation output unit and transmits information pertinent to the output suppression from the communication unit of the power-generation power conditioner to the power-storage power conditioner.

8. The power conditioner system according to claim **7**, wherein the power-storage power conditioner, when the communication unit thereof receives the information pertinent to the output suppression from the power-generation power conditioner, makes itself offline from the grid and stores the output power of the independent-power-generation output unit in the power storage equipment.

9. The power conditioner system according to claim **7**, wherein the power-generation power conditioner is subjected to output suppression upon increase in a system voltage of the grid, upon entering date/time designated by a calendar function, or upon an offline instruction received by the communication unit of the power-generation power conditioner itself.

10. The power conditioner system according to claim **3**, wherein the power-generation power conditioner, when making itself offline from the grid, transmits information including the operation state from the communication unit thereof to the power-storage power conditioner and outputs power based on generated power of the power generation equipment from the independent-power-generation output unit.

11. The power conditioner system according to claim **3**, wherein

the power-generation power conditioner transmits information about power based on the generated power of the power generation equipment from the communication unit thereof to the power-storage power conditioner, and

the power-storage power conditioner, when the communication unit thereof receives the information about the power based on the generated power of the power generation equipment from the power-generation power conditioner, controls a charging amount of the power storage equipment based on the received information.

12. The power conditioner system according to any one of claims **1**, wherein the power-storage power conditioner, when detecting connection of the independent-power-generation output unit to the power-storage power conditioner, supplies at least one of the AC power based on the output power of the independent-power-generation output unit, the AC power based on the output power of the independent-power-storage output unit, and the system power of the grid, to a predetermined independent output system.

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